

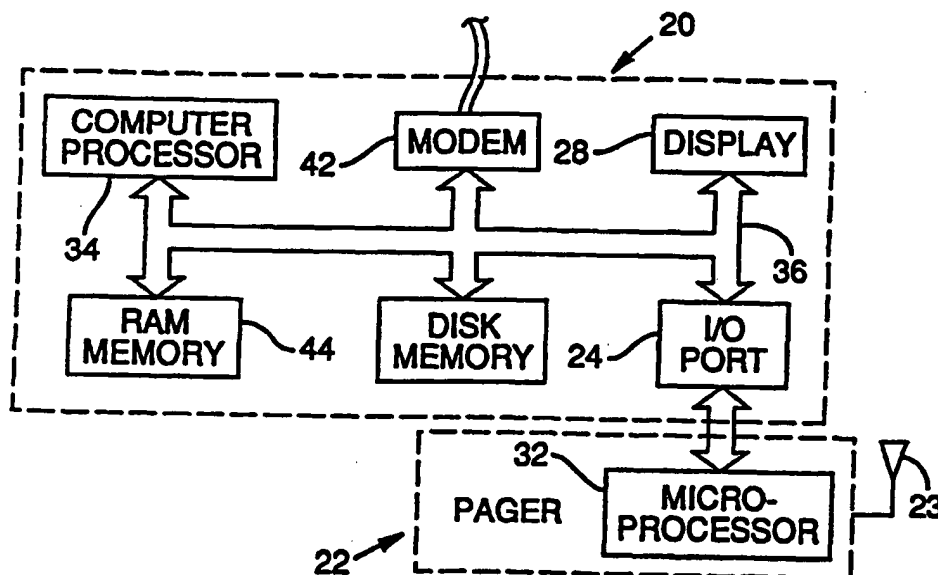


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<b>(21) International Application Number:</b> PCT/US91/00731 <b>(22) International Filing Date:</b> 4 February 1991 (04.02.91) <b>(30) Priority data:</b> 473,791                      2 February 1990 (02.02.90)      US <b>(71) Applicant:</b> AT&E CORPORATION [US/US]; One Maritime Plaza, Suite 500, San Francisco, CA 94111 (US). <b>(72) Inventor:</b> GASKILL, Garold, B. ; 10285 SW Moratoc Drive, Tualatin, OR 97062 (US). <b>(74) Agent:</b> GALBI, Elmer, W.; AT&E Corporation, 10450 S.W. Nimbus Avenue, Portland, OR 97223 (US).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), SE (European patent).  <b>Published</b> <i>With international search report.          Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

**(54) Title:** PAGER EQUIPPED COMPUTER**(57) Abstract**

An improved personal computer (20) includes an interface (24) to a paging receiver (22), thereby providing, among other advantages, remote communication and control capabilities not heretofore known in either the paging or computer arts.

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PAGER EQUIPPED COMPUTER2 Related Application Data

3 The present application is a continuation-in-part of  
4 copending application Serial No. 07/356,630, filed May  
5 30, 1989, which is a division of Serial No. 06/802,844,  
6 filed November 27, 1985, now U.S. Patent 4,713,808, and  
7 is also a continuation-in-part of copending application  
8 Serial No. 07/326,491, filed March 17, 1989, which is a  
9 continuation of Serial No. 07/101,252, filed September  
10 25, 1987 and now abandoned, which is a division of Serial  
11 No. 06/802,844, filed November 27, 1985, now U.S. Patent  
12 4,713,808.

13 Field of the Invention

14 The present invention relates to radio paging systems,  
15 and more particularly to the combination of such paging  
16 systems with personal computers.

17 Background and Summary of the Invention

18 Personal computers are important and widely used tools in  
19 our society. Many personal computer have communication  
20 capabilities such as modems or connections to LANS (i.e.  
21 local area networks). Furthermore some computer modems  
22 have the capability of communicating by radio signals.

23 Radio paging systems are also important and widely used  
24 systems in our society. A radio paging system is a  
25 specialized type of communication system which is  
26 designed to alert an individual that someone is seeking

1 to contact them. Such systems are relatively low cost  
2 and they generally communicate short messages in only one  
3 direction with no automatic acknowledgement capability.  
4 An example of a radio paging system is shown in U.S.  
5 Patent 4,713,808 (Gaskill) which is assigned to the  
6 assignee of the present invention.

7 The capabilities of traditional personal computers and  
8 traditional radio pagers have not heretofore been  
9 exploited in tandem. The present invention  
10 advantageously couples these two technologies and in so  
11 doing, provides a number of important features not  
12 previously achieved in either the personal paging or  
13 computer arts.

14 In todays society, many people spend long hours watching  
15 the screens of their personal computer. Combining a  
16 radio paging network with a personal computer provides a  
17 very effective means of communicating paging messages to  
18 such people.

1 Summary of the Invention

2 In accordance with the present invention, a personal  
3 computer (either desktop, laptop, or notebook) is  
4 provided with a paging receiver. The pager enhances the  
5 computer's general purpose utility by providing it with a  
6 means of receiving short messages without unduly  
7 burdening the computer with overhead housekeeping  
8 operations. The computer likewise enhances the pagers  
9 utility by providing a means for displaying paging  
10 messages on the screen where an operator will readily see  
11 them and by providing logging and acknowledgement  
12 capability. The combined system can provide new  
13 features, such as audit trails, multi-address paging  
14 reception, and dial-up feedback to the originating paging  
15 system, that have previously been unknown in the personal  
16 paging art.

17 The foregoing and additional features and advantages of  
18 the present invention will be more readily apparent from  
19 the following detailed description thereof, which  
20 proceeds with reference to the accompanying drawings.

21 Brief Description of the Drawings

22 Fig. 1 is a schematic diagram of a paging system  
23 employing a pager equipped computer according to one  
24 embodiment of the present invention.

25 Fig. 1A is a diagram of one of the printed circuit plug  
26 in cards in the personal computer shown in Fig. 1.

1 Fig. 2 is a schematic block diagram of a paging receiver  
2 used in the pager equipped computer of Fig. 1.

3 Fig. 3 is a schematic block diagram illustrating the  
4 pager equipped computer of Fig. 1.

5 Fig. 4 is a flow chart illustrating operation of  
6 interfacing software used in the pager equipped computer  
7 of Fig. 1.

8 Fig. 5 is a map of RAM memory used in the personal  
9 computer of Fig. 1.

10 Detailed Description

11 Applicant hereby incorporates by reference the  
12 disclosures of US Patents 4,897,835, 4,893,341,  
13 4,885,802, 4,870,372 and 4,713,808, each of which is  
14 owned by the present assignee and relates to a paging  
15 system (the "Gaskill system") with which the present  
16 invention is illustrated.

17 Referring to Fig. 1, the illustrated paging system 10  
18 includes a clearinghouse 12, a plurality of transmitter  
19 stations 14, a plurality of wristwatch paging receivers  
20 16, and one or more pager/computers 18. As described in  
21 the previously referenced patents, the clearinghouse 12  
22 is a automated centralized facility which accepts  
23 telephone messages, validates customer identification,  
24 determines message destinations, and routes messages to

1 the appropriate transmitter stations for transmission.  
2 Callers to the system dial a local clearinghouse  
3 telephone number and hear voice prompts which guide them  
4 through a simple process for sending messages. Each  
5 transmitter station 14 in the illustrated embodiment is  
6 an FM radio station that modulates paging signals on a  
7 subcarrier of its broadcast signal, as detailed in the  
8 above-referenced Gaskill patents.

9 The paging receivers 16 are wrist mounted devices which  
10 include radio paging circuitry in a case which has a  
11 wristwatch form factor. An important aspect of a paging  
12 system is that the paging receiver should be located so  
13 that the display can be viewed easily and often.  
14 Locating the paging message display in a wristwatch and  
15 in the screen of a prsonal computer satisfies this  
16 requirement.

17 Each pager/computer 18 comprises a conventional personal  
18 computer 20, which has a special card plugged into its  
19 bus. The additional card 22A is shown in Figure 1A.  
20 Card 22A has a series of contacts 22C which fit into a  
21 standard PC bus slot and a standard holding bracket 22D.  
22 Card 22A has mounted thereon a paging receiver of the  
23 type described in the above reference patent application.  
24 Standard interface circuitry 24 connects circuit 22 to the  
25 appropriate power and data interface pins in connector  
26 22C and provides the other standard interface circuitry  
27 needed by a PC plug in card. Paging receiver 22 receives

1 radio signals over an antenna 23 which extends outside  
2 the PC's metal case.

3 Personal computers 20 are well known in the art and are  
4 available from a variety of vendors, including IBM, Apple  
5 and Compaq. The computer 20 in Fig. 1 is illustrated  
6 with an associated screen display 28 that includes a  
7 window 30 in which paging messages may be presented. It  
8 should be noted that a personal computer is a  
9 fundamentally different device than what is often termed  
10 a microprocessor. A personal computer generally includes  
11 a microprocessor, but a personal computer is a device  
12 that includes in addition to a microprocessor, a memory  
13 system, I/O for alphanumeric textual material, and an  
14 operating system for handling alphanumeric textual  
15 material and commands.

16 As described in the above referenced patent, paging  
17 receiver 22 is highly miniaturized and it could be  
18 mounted directly to the rear panel of the computer rather  
19 than being mounted on a separate card. The only evidence  
20 that the computer 12 includes a pager would be a small  
21 antenna 23 extending therefrom. The paging receiver 22  
22 includes a small microprocessor 32 to implement the  
23 pager's repertoire of functions. In the present  
24 embodiment processor 32 is dedicated to control of the  
25 pager circuitry.

26 Interfacing of the paging receiver 22 to the computer 20  
27 is effected by a hardware interface 24, which is

1 recognized and controlled by an associated software  
2 routine 26 (Fig. 5). The hardware interface can be one  
3 of two types. In the first type, the interface connects  
4 the paging receiver directly to the system bus 36 of the  
5 personal computer. Such an implementation is desirable  
6 if the paging receiver is included as an integral part of  
7 the computer, rather than as a peripheral. In the second  
8 type, (not shown) the interface connects the paging  
9 receiver to one of the computer's external I/O ports.  
10 Interface through an external I/O port eliminates the  
11 need for any dedicated interfacing hardware. Rather, the  
12 interfacing hardware is the computer's own I/O card.

13 Fig. 4 illustrates, in flow chart fashion, an  
14 illustrative software interfacing routine 26 that may be  
15 executed on the computer 20 to interface the paging  
16 receiver 22. The details of illustrative paging  
17 receivers 22 and their control microprocessors are  
18 described in the above-referenced patents and are not  
19 repeated here. Similarly, the basics of interfacing  
20 peripheral devices through I/O ports of personal  
21 computers are also well known in the art and well  
22 described in the literature.

23 Routine 26 is an interrupt service routine that is  
24 invoked by the  
25 computer's processor 34 in response to an interrupt  
26 request signal issued by the pager to the computer's I/O  
27 port 24. The pager can issue an interrupt request signal  
28 in response to a number of events, most usually the  
29 receipt of a paging message. In response to such an

1 interrupt signal, the computer processor 34 saves its  
2 current machine state and associated pointers in  
3 registers and executes the routine 26.

4 As can be seen from Fig. 4, the illustrated interrupt  
5 routine 26, once invoked, causes the computer's processor  
6 to read an instruction word (4-bits) provided to the I/O  
7 port by the pager. This instruction word is composed by  
8 the pager microprocessor in accordance with the operation  
9 it wants the computer's processor to perform, as detailed  
10 more fully below. The routine 26 examines this  
11 instruction word and serially compares it against its  
12 sixteen possible values. When a match is found, the  
13 computer processor 34 has identified what function has  
14 been requested and invokes a corresponding one of a  
15 plurality of service routines A, B, C, etc.

16 The particular steps executed by service routines A, B,  
17 C, etc. depend on the desired functionality of the pager-  
18 equipped computer. The following discussion details a  
19 few illustrative functions.

20 In a first function, the pager can invoke the large data  
21 storage capacity of the computer to compile a historical  
22 audit trail of all paging messages directed to one (or  
23 more) paging addresses. In the illustrated embodiment,  
24 this function is invoked by the pager issuing an  
25 interrupt request to the computer and providing the  
26 instruction word '0001' to the I/O port each time a new  
27 message is received by the pager. (The pager already has

1 the capability to energize a "message waiting"  
2 annunciator on its display when a message is received,  
3 and the signal driving this annunciator can be provided  
4 to the least significant bit of the instruction word bits  
5 on the I/O port to yield the '0001' instruction word.)

6 In response to this '0001' instruction, the computer  
7 processor can open a disk file containing a chronological  
8 compilation of all messages received to date and can  
9 provide back to the pager processor a signal instructing  
10 it to provide the newly received message, one ASCII  
11 character at a time, through the I/O port. This data,  
12 which may include a date and time tag, are added to the  
13 disk file. When an end-of-field character is encountered  
14 among the data, the computer processor closes its disk  
15 file and resumes its normal operation. Desirably, the  
16 computer signals the response of a new message with a  
17 screen icon or a beep to the user.

18 According to this aspect of the invention, the user may,  
19 at his convenience, review newly received messages, or  
20 may review earlier messages archived in the file. Such a  
21 feature provides a backup capability in case the user's  
22 usual pager misses a page for any reason, and also  
23 provides an archival backup in case the contents or the  
24 existence of a page ever become an issue.

25 In a second function, the pager can invoke the display  
26 capabilities of the computer to display messages as they  
27 are received. Such a function is especially useful for

1 long messages, which may be somewhat tedious to review  
2 word by word on a wristwatch pager's limited display.  
3 This function is performed similarly to the audit trail  
4 function but, instead of writing the data to a disk file  
5 (or in addition thereto), the computer, on command,  
6 presents a window on the computer screen and displays the  
7 text in the window. (The presentation of a window on a  
8 display is well known in the computer arts and is  
9 illustrated, for example, in U.S. Patents 4,868,765,  
10 4,862,389, 4,860,247, 4,860,218, 4,839,805, 4,823,108,  
11 4,794,386, 4,769,762, 4,769,636, 4,633,415, 4,555,775 and  
12 4,481,603, the disclosures of which are incorporated  
13 herein by reference.)

14 In a related embodiment, a line at the bottom of the  
15 screen is dedicated at all times to display of the most  
16 recent message, and includes an indication of the total  
17 number of pages received in the past 24 hours. By this  
18 arrangement, the user is constantly "on-line" and  
19 monitoring transmissions as they occur.

20 In one embodiment, the originating paging system 12 can  
21 be informed that a particular user has a computer  
22 available to display long messages. In such case, rather  
23 than having the user's wristwatch unit receive and store  
24 lengthy messages, the originating system can instead  
25 transmit the message with a datum that indicates the  
26 message is to be received and stored by the computer  
27 only. The system can send to the wristwatch pager a

1 different message indicating that a lengthy message has  
2 been sent to the user's computer.

3 In a third function, which may optionally be performed in  
4 tandem with any of the foregoing functions, the computer  
5 may check to insure that no messages have been missed.  
6 In the preferred embodiment of the Gaskill paging system,  
7 each message is sent with a consecutive message number.  
8 As these messages are transferred to the personal  
9 computer, the computer checks that the message number of  
10 each newly received message follows in sequence with the  
11 immediately preceding message. If the computer notes  
12 that message 4 is followed by message 6, it deduces that  
13 message 5 has been missed. In response to this  
14 determination, the computer presents an advisory notice  
15 to the user on the computer display. In a more  
16 sophisticated embodiment, the computer executes a  
17 communications program that telephones a paging control  
18 station 12 using an associated modem 42 and sends a  
19 scripted series of commands to the system into which the  
20 number of the missing page has been inserted. This  
21 script causes the paging system to rebroadcast the  
22 missing message. Such an embodiment thereby closes the  
23 loop between the paging system and the user, insuring  
24 high data integrity.

25 In a related embodiment, a modem is employed to  
26 selectively telephone the paging system and confirm  
27 receipt of a paging message. Such a procedure, while  
28 overwhelming if practiced generally, is instituted in

1 response to a series of control bits included with the  
2 paging message indicating that the accompanying page is a  
3 special one that should be affirmatively acknowledged.

4 The pager equipped computer may be programmed to respond  
5 not to just one paging address, but to a plurality of  
6 individual addresses. By such an arrangement, the  
7 associated personal computer logs or displays messages  
8 addressed to a group of users, such as members of a  
9 family or employees of a certain business, instead of  
10 just one. In the normal operation a pager only accepts a  
11 message if there is a complete match on the entire 32 bit  
12 address. By doing a match on less than the entire 32  
13 bits, a pager can be programmed to accept messages  
14 directed to an entire group of pagers. Alternately, by  
15 providing a pager with additional programming, the pager  
16 could be programmed to match a received address against a  
17 number of desired addresses and thereby accept messages  
18 addressed to anyone of a plurality of ID numbers. With  
19 the present system, the capability of receiving messages  
20 with more than one ID can be programmed in the pager  
21 itself, or it can be programmed in response to commands  
22 from the personal computer. Alternately, the pager can  
23 send all messages to the personal computer, and the  
24 personal computer can screen the messages and only select  
25 those with certain ID codes.

26 In the simplest embodiment, the recipient address  
27 decoding function is performed in the pager as described  
28 in the referenced patent. However, as an alternative the

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1 pager could send all messages that are received to the  
2 personal computer and the address decoding could be  
3 performed in the personal computer. The shifting of this  
4 processing burden to the computer permits the monitored  
5 addresses to be easily modified or updated as users join  
6 or leave the group of interest. Irrespective of where  
7 the decoding is performed, the pager operation does  
8 require an address compare operation in order to make the  
9 pager addressable from the central facility.

10 In a fourth function, the computer may monitor incoming  
11 messages for a special symbol that indicates that the  
12 associated message is not textual, but rather contains  
13 instructions that the computer is to use to control some  
14 other apparatus. For example, some computers are  
15 presently used to control home appliances, lighting, and  
16 heating/air conditioning equipment. The non-textual  
17 instructions may be decoded by the computer and cause it  
18 to turn on lights, turn down the heat, etc.

19 The interrupt routine and each of the above-described  
20 service routines may be in the form of terminate and stay  
21 resident programs (TSRs) loaded into the computer's RAM  
22 memory 44 when the computer is booted. Fig. 5 is a map  
23 of the computer memory showing these programs.

24 From the foregoing it will be recognized that the  
25 equipping of a computer with a paging receiver provides a  
26 number of communication and control capabilities that  
27 have not heretofore been available in either the computer

1 or paging arts. Still further, the combination provides  
2 certain benefits beyond those of the communication and  
3 control type. One such benefit is the availability of a  
4 highly accurate source of time data to the computer. The  
5 Gaskill paging system transmits highly accurate time data  
6 to each of the paging receivers to synchronize their  
7 operation to that of the originating system 12. This  
8 data can be used advantageously in unrelated applications  
9 to which the computer may be put, including scientific  
10 measurement applications in which a precision clock is  
11 essential.

12 Having described and illustrated the principles of our  
13 invention with reference to a preferred embodiment  
14 thereof, it will be apparent that the invention can be  
15 modified in arrangement and detail without departing from  
16 such principles. For example, while the invention has  
17 been illustrated with reference to a conventional  
18 personal computer, it will be recognized that the  
19 invention may similarly be applied to portable or  
20 notebook computers, thereby further enhancing the  
21 invention's utility. Further, it will be recognized that  
22 a great number of functions beyond the limited repertoire  
23 detailed above may be implemented using the basic pager  
24 equipped computer invention.

25 Finally, it will be recognized that the invention finds  
26 applicability with a number of paging systems besides the  
27 illustrated Gaskill system. Other paging systems are  
28 taught, together with details of other pager instruction

1 sets, in U.S. Patents 3,166,752, 3,427,633, 3,623,189,  
2 3,647,356, 3,668,528, 3,693,089, 3,742,481, 3,902,022,  
3 3,911,416, 3,980,952, 4,103,286, 4,151,367, 4,160,240,  
4 4,181,893, 4,237,448, 4,247,893, 4,283,796, 4,359,133,  
5 4,370,753, 4,378,551, 4,385,295, 4,398,192, 4,412,217,  
6 4,419,668, 4,438,433, 4,500,961, 4,513,068, 4,521,776,  
7 4,523,332, 4,545,695, 4,578,739, 4,613,859, 4,618,860,  
8 4,618,946, 4,639,726, 4,644,347, 4,644,350, 4,649,538,  
9 4,654,631, 4,661,972, 4,682,148, 4,691,281, 4,701,759,  
10 4,704,740, 4,713,659, 4,718,109, 4,720,710, 4,727,485,  
11 4,734,694, 4,737,978, 4,745,408, 4,754,423, 4,763,244,  
12 4,763,250, 4,766,434, 4,766,537, 4,768,031, 4,769,641,  
13 4,775,998, 4,775,999, 4,779,091, 4,786,902, 4,800,489,  
14 4,804,955, 4,805,097, 4,811,379, 4,812,813, 4,814,763,  
15 4,821,021, 4,823,123, 4,825,193, 4,835,777, 4,839,641,  
16 4,845,485, 4,849,750, 4,851,830, 4,853,688, 4,855,731,  
17 4,857,911, 4,857,915, 4,864,276, 4,866,431, 4,868,558,  
18 4,868,561, 4,868,562, 4,868,563, 4,868,860, 4,870,410,  
19 4,875,038, 4,875,038, 4,875,039, 4,875,039, 4,876,537,  
20 4,876,537, 4,876,538, 4,876,538, 4,878,051, 4,878,051,  
21 4,879,733, 4,880,712, 4,881,073, 4,881,150 and 4,882,579,  
22 the disclosures of which are incorporated herein by  
23 reference.

24 In view of the many possible embodiments to which our  
25 invention is susceptible, it should be recognized that  
26 the detailed embodiment is illustrative only and should  
27 not be taken as limiting the scope of our invention.  
28 Rather, we claim as our invention all such embodiments as  
29 may fall within the scope and spirit of the following

1 claims and equivalents thereto.

1 WE CLAIM:

2 1. A computational and messaging system comprising:

3 a personal computer, said personal computer including a  
4 microprocessor, a memory, a display screen, an I/O  
5 interface, and an operating system,

6 a radio paging receiver adapted to receive paging  
7 messages and to produce output data corresponding  
8 thereto,

9 means coupling said paging receiver to said I/O interface  
10 in said personal computer,

11 means for selecting paging messages according to  
12 specified criteria and for providing said selected  
13 messages for further processing,

14 programming means associated with said personal computer  
15 for manipulating, acting upon and displaying data  
16 received from said radio paging receiver,

17 whereby messages can be sent to said personal computer  
18 over a radio paging network and operated on by said  
19 personal computer.

- 1 2. The system recited in claim 1 including,
- 2 a paging message clearing house which can be reached by
- 3 normal telephone, and
- 4 means for sending to said computer paging messages
- 5 telephoned to said pager clearing house.
- 6 3. A paging method comprising the steps:
- 7 providing a personal computer having a individually
- 8 addressable paging receiver interfaced thereto;
- 9 receiving paging messages addressed to a predetermined
- 10 recipient;
- 11 providing data corresponding to said received paging
- 12 messages from the paging receiver to the personal
- 13 computer; and
- 14 storing said data in a memory associated with the
- 15 personal computer.

- 1 4. The method of claim 3 which further includes:
- 2 providing an interrupt signal to the personal computer  
3 from the paging receiver in response to receipt of a  
4 paging message addressed to the predetermined recipient;
- 5 responding to said interrupt signal by invoking an  
6 interrupt routine on a processor integral to the personal  
7 computer; and
- 8 providing the data corresponding to said received message  
9 from the paging receiver to the personal computer in  
10 reply to said interrupt routine.
- 11 5. The method of claim 3 in which a paging transmitter  
12 broadcasts paging messages to a first plurality of  
13 recipients and in which the method further includes the  
14 steps:
- 15 receiving paging messages addressed to a second plurality  
16 of predetermined recipients, said second plurality  
17 comprising less recipients than the first plurality.
- 18 6. A paging method comprising the steps:
- 19 providing a personal computer having a paging receiver  
20 interfaced thereto;

- 1 receiving paging messages addressed to a predetermined
- 2 recipient;
- 3 providing data corresponding to said received paging
- 4 messages from the paging receiver to the personal
- 5 computer; and
- 6 displaying said data on a display screen associated with
- 7 the personal computer.

1 7. The method of claim 6 which further includes:

2 storing the data in a memory associated with the personal  
3 computer;

4 indicating to the user of the personal computer that a  
5 message has been received; and

6 displaying the data on the display screen in response to  
7 a command issued by the user.

8 8. The method of claim 7 in which the displaying step  
9 includes presenting a window on the display screen and  
10 displaying the data in said window.

11 9. The method of claim 5 in which a paging transmitter  
12 broadcasts paging messages to a first plurality of  
13 recipients and in which the method further includes the  
14 steps:

15 receiving paging messages addressed to a second  
16 predetermined plurality of recipients, said second  
17 plurality comprising less recipients than the first  
18 plurality.

- 1 10. A paging system comprising,
- 2 a plurality of individually addressable paging receivers
- 3 in cases with wristwatch form factors,
- 4 a personal computer and an individually addressable
- 5 paging receiver interfaced with said personal computer,
- 6 a message clearing house which can receive telephoned
- 7 messages and transmit said messages to said individually
- 8 addressable paging receivers,
- 9 whereby messages from said clearinghouse can be made to
- 10 appear either on a wristmounted pager or on the screen of
- 11 a personal computer.

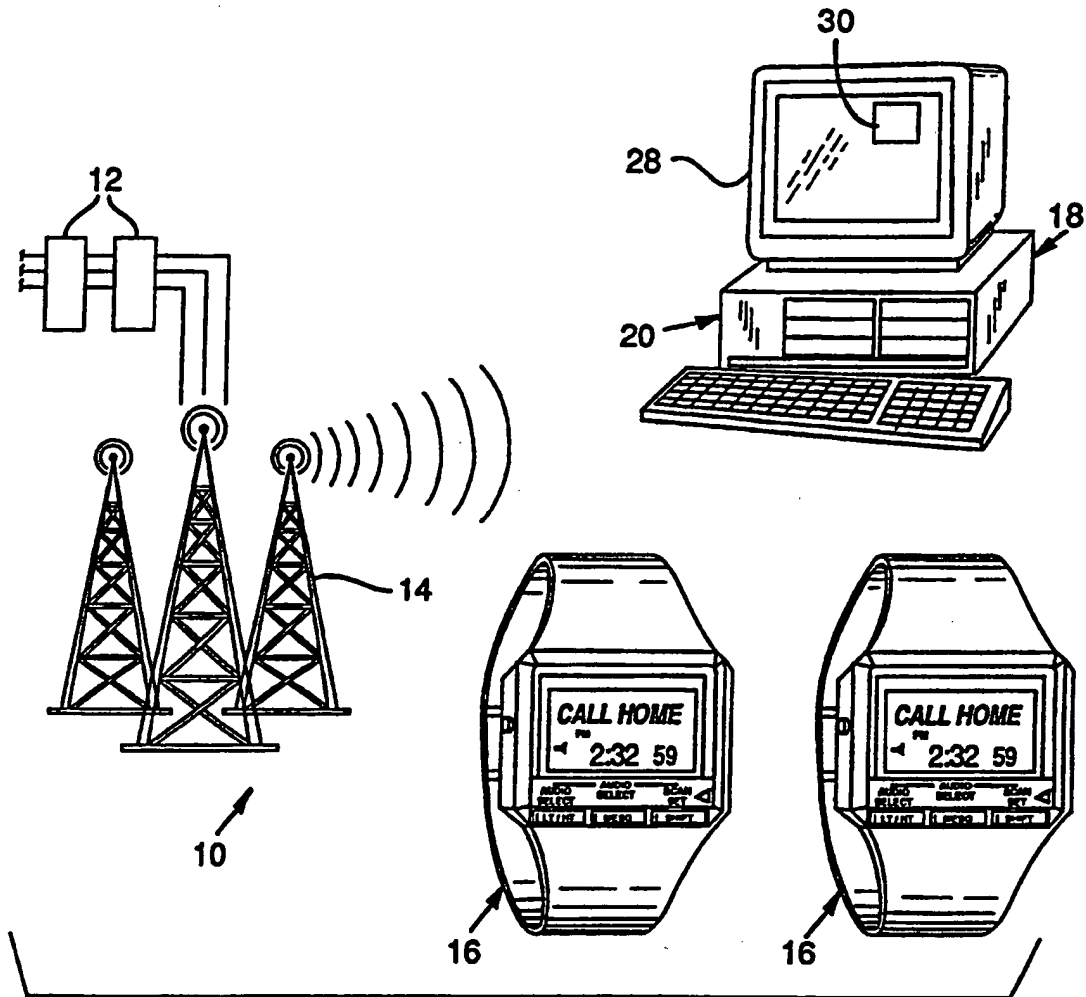
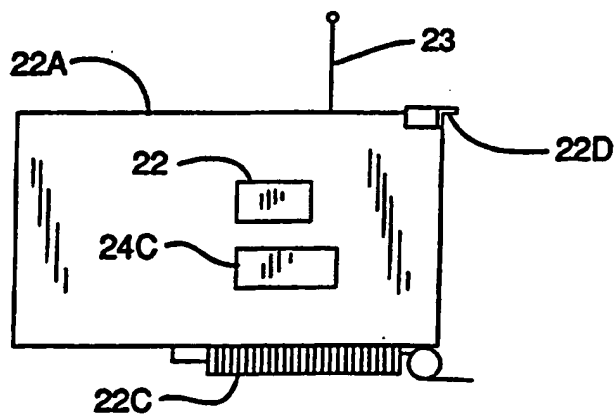


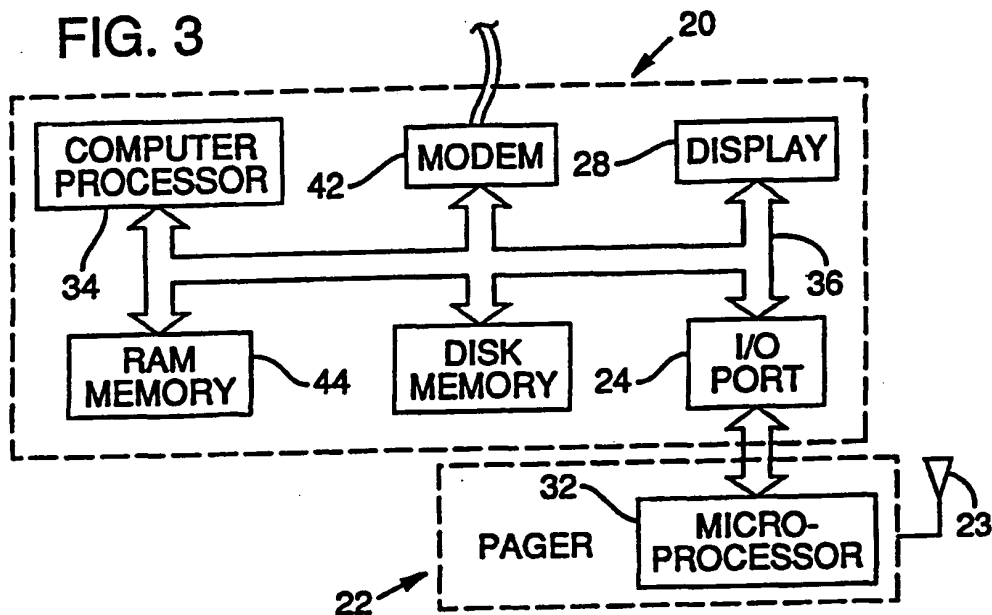
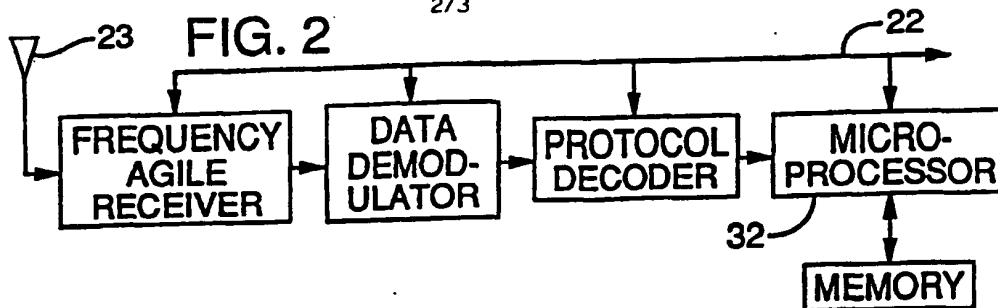
FIG. 1

FIG. 1A

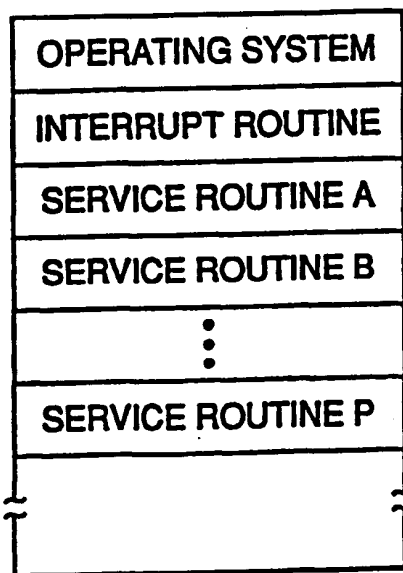


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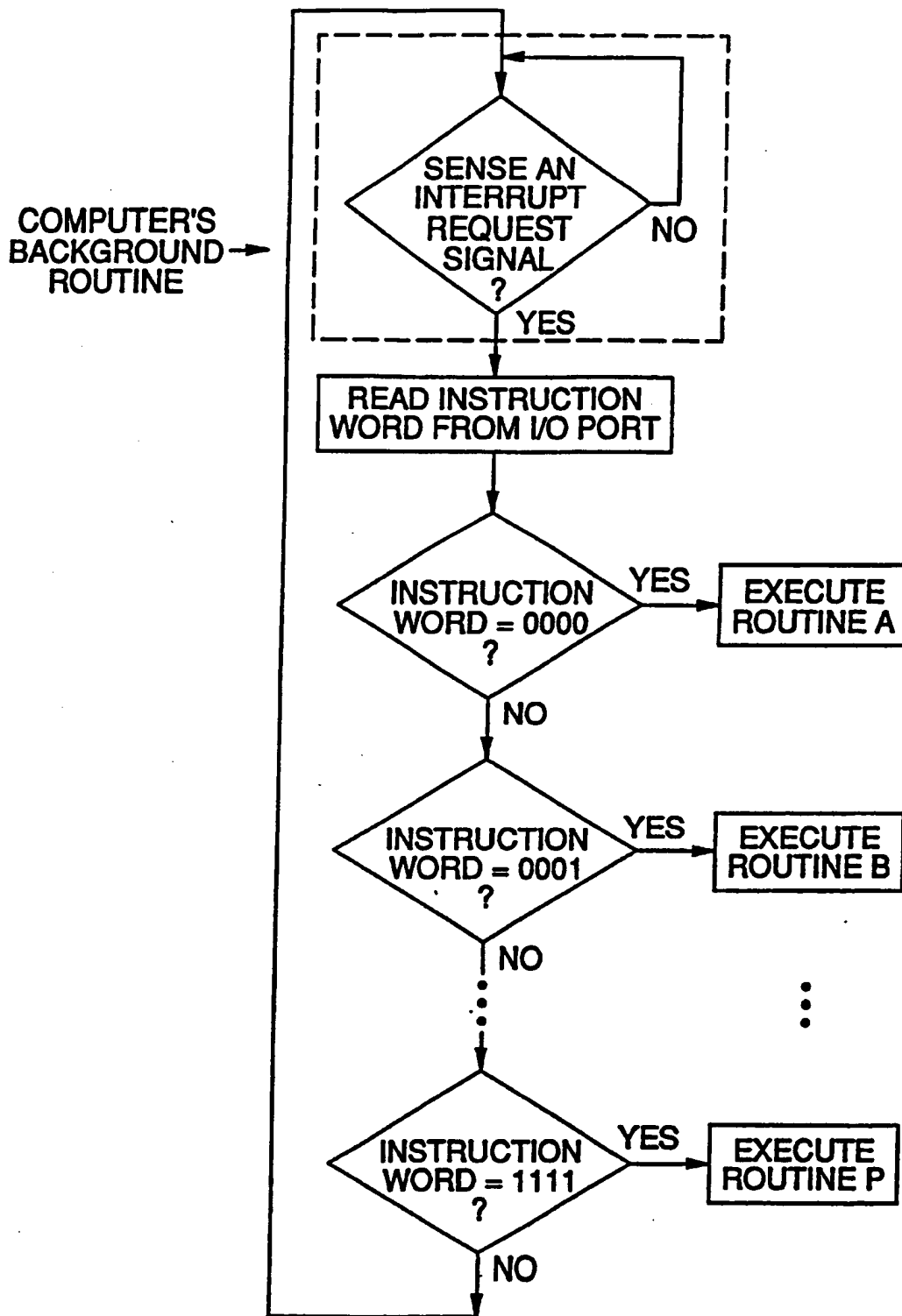
**FIG. 5** RAM MEMORY



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FIG. 4

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# INTERNATIONAL SEARCH REPORT

International Application No **PCT/US91/00731**

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>1</sup>	
According to International Patent Classification (IPC) or to both National Classification and IPC	
IPC (5): <b>H04Q 7/00; G08B 5/22</b>	
U.S. CL: <b>340/825.44</b>	
<b>II. FIELDS SEARCHED</b>	
Minimum Documentation Searched <sup>4</sup>	
Classification System <sup>1</sup>	Classification Symbols
U.S.	340/825.44, 825.47, 311.1 379/56,57,63 358/84 455/31,32,38 364/705.05
Documentation Searched other than Minimum Documentation to the extent that such documents are included in the fields searched <sup>4</sup>	

<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>12</sup>		
Category <sup>9</sup>	Citation of Document, <sup>14</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>12</sup>
Y	US, A, 3,976,995 (SEBESTYEN) 24 August 1976 See abstract, Figs. 1-3, col.2, line 47- col. 3, line 3.	1-10
Y	US, A, 4,644,351 (ZABARSKY ET AL.) 17 February 1987, See abstract, Fig. 1, 10, col. 4, line 32-col. 5, line 12.	1-10
P,Y	US, A, 4,972,457 (O'SULLIVAN) 20 November 1990, See abstract, figs. 4,6, col. 6, lines 6-11, col. 7, line 7-col. 8, line 8.	1-10
Y	US, A, 4,383,257 (GIALLANZA, ET AL.) 10 May 1983, See fig. 1, col. 1, lines 52-59 col. 3, line 59-col. 6, line 10.	5;9
Y	US, A, 3,937,004 (NATORI, ET AL.) 10 February 1976, See abstract, Fig. 1, col. 1, lines 49-66.	10
A	US, A, 4,806,906 (ODA, ET AL.) 21 February 1989, See abstract, Fig. 1, col. 1.	1,3,6,10
Y	USA, 4,750,036 (MARTINEZ) 07 JUNE 1988 See abstract, col. 10, line 11, col. 11, line 64, figs. 1,3.	1-10

<sup>9</sup> Special categories of cited documents: <sup>13</sup>

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search <sup>1</sup>

**29 APRIL 1991**

International Searching Authority <sup>1</sup>

ISA/US

Date of Mailing of this International Search Report <sup>1</sup>

30 MAY 1991

Signature of Authorized Officer <sup>18</sup>

**EDWIN C. HOLLOWAY III**